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Marshall Space Flight Center, Alabama 35812
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Manager of Public and Employee Communications: June E. Malone
Editor: Jenalane Rowe

Celebrate! Join in Orion Launch Activities, Holiday Tree Lighting on Dec. 4

By Megan Davidson

Team Redstone -- which includes NASA's Marshall Space Flight Center and U.S. Army organizations on Redstone Arsenal -- are invited to participate in several events in celebration of Orion's first flight test, and end the day with a little holiday cheer.

On Dec. 4, Orion will launch atop a Delta IV Heavy rocket from Cape Canaveral Air Force Station's Space Launch Complex 37. The flight test will

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Open for Business: 3-D Printer Creates First Object in Space on International Space Station

By Bill Hubscher

The International Space Station's 3-D printer has manufactured the first 3-D printed object in space, paving the way to future long-term space expeditions.

"This first print is the initial step toward providing an on-demand machine shop capability away from Earth," said Niki Werkheiser, project manager for the International Space Station 3-D Printer at NASA's

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International Space Station Commander Barry "Butch" Wilmore holds up the completed first object created in space using additive manufacturing or 3-D printing. Wilmore installed the printer on Nov. 17, and helped crews on the ground with the first print on Nov. 25. (NASA)

Orion Launch Activities *Continued from page 1*

evaluate launch and high-speed re-entry systems such as avionics, attitude control, parachutes and the heat shield. During its two-orbit, 4.5-hour flight, Orion will venture 3,600 miles in altitude and travel nearly 60,000 miles before returning to Earth for a splashdown in the Pacific Ocean.

Starting at 5 a.m. Dec. 4, the U.S. Space & Rocket Center will provide live coverage of the launch -- scheduled for 6:05 a.m. CST -- in the Davidson Center for Space Exploration Digital Theater. The launch window extends to 8:44 a.m. Educational activities for kids will be held immediately following the launch through splashdown -- scheduled for 10:29 a.m. if launch occurs at the start of the window.

Marshall representatives will be on hand to answer questions about the launch. The event is free, and breakfast will be available for purchase. Guests will receive a complimentary VIP launch pass lanyard. Marshall team members are encouraged to wear NASA apparel and take pictures of themselves to post to the Marshall social media accounts using the hashtags #orion and #nasasocial.

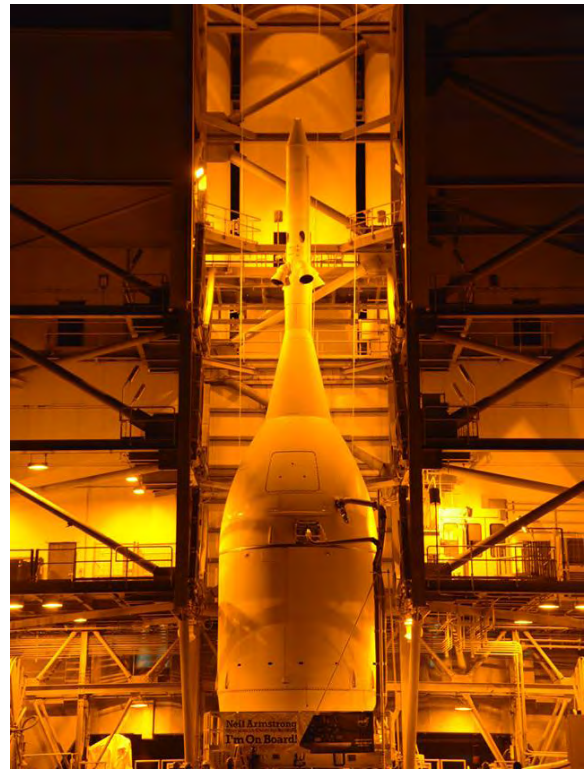
Back at the Marshall Center, senior leadership will be hosting the Orion Splashdown Party at 11 a.m. in the Building 4203 cafeteria. Monitors will show NASA TV coverage of the Orion splashdown. The Army Materiel Command Band will provide entertainment, and light refreshments will be served.

To conclude the day's events, the Marshall Exchange will host the annual holiday tree-lighting ceremony at 4:45 p.m. on the front lawn of Building 4200. Santa Claus will make an appearance, and children from the Marshall Child Development Center will sing seasonal songs. Cookies and hot chocolate will be provided.

NASA TV will carry live coverage of the Orion's launch and splashdown beginning at 4 a.m. CST. The launch will also be streamed on online at www.nasa.gov/nasatv.

Marshall's Role in Orion's First Flight

Teams at the Marshall Center have provided critical support ahead of Orion's flight. Marshall has fabricated almost 1,000 pieces of Orion flight and ground test hardware; conducted structural testing of the service module and crew module elements; and managed oversight of the launch abort system propulsion elements.



NASA's Orion spacecraft completed its move to Cape Canaveral Air Force Station Space Launch Complex 37 at 3:07 a.m. Nov. 12. After arrival at the launch pad, engineers and technicians will lift Orion and mount it atop a United Launch Alliance Delta IV Heavy rocket. Orion is scheduled to launch Dec. 4 atop the Delta IV for its first unpiloted flight test, and in 2018 on NASA's Space Launch System. SLS will be the most powerful rocket ever built for deep space missions. The Marshall Center manages the SLS Program for the agency. For more on Marshall role in Orion's first test flight, [click here](#). (NASA)

The stage adapter that will connect the Orion to the Delta IV Heavy for the flight was designed, built and tested at Marshall. Marshall also conducted pressurized testing for the adapter diaphragm -- which will keep gases away from the spacecraft.

In the future, Orion will launch on NASA's new rocket, the Space Launch System. More powerful than any rocket ever built, SLS will be capable of sending humans to deep space destinations, including to an asteroid and ultimately Mars. The Marshall Center manages the SLS Program for the agency.

Davidson, an ASRC Federal/Analytical Services employee, supports the Office of Strategic Analysis & Communications.

3-D Printer *Continued from page 1*

[Marshall Space Flight Center](#). “The space station is the only laboratory where we can fully test this technology in space.”

NASA astronaut Barry “Butch” Wilmore, Expedition 42 commander aboard the [International Space Station](#), installed the printer on Nov. 17 and conducted the first calibration test print. Based on the test print results, the ground control team sent commands to realign the printer and printed a second calibration test on Nov. 20. These tests verified that the printer was ready for manufacturing operations. On Nov. 24, ground controllers sent the printer the command to make the first printed part: a faceplate of the extruder’s casing. This demonstrated that the printer can make replacement parts for itself. The [3-D printer](#) uses a process formally known as additive manufacturing to heat a relatively low-temperature plastic filament and extrude it one layer at a time to build the part defined in the design file sent to the machine.

On the morning of Nov. 25, Wilmore removed the part from the printer and inspected it. Part adhesion on the tray was stronger than anticipated, which could mean layer bonding is different in microgravity, a question the team will investigate as future parts are printed. Wilmore installed a new print tray, and the ground team sent a command to fine-tune the printer alignment and printed a third calibration sample. When Wilmore removes the calibration print, the ground team will be able to command the printer to make a second object. The ground team makes precise adjustments before every print, and the results from this first print are contributing to a better understanding about the parameters to use when 3-D printing on the space station.

“This is the first time we’ve ever used a 3-D printer in space, and we are learning, even from these initial operations,” Werkheiser said. “As we print more parts we’ll be able to learn whether some of the effects we are seeing are caused by microgravity or just part of the normal fine-tuning process for printing. When we get the parts back on Earth, we’ll be able to do a more detailed analysis to find out how they compare to parts printed on Earth.”

The [3-D Printing in Zero-G Technology Demonstration](#) on the space station aims to show

additive manufacturing can make a variety of 3-D printed parts and tools in space. The first object 3-D printed in space, the print head faceplate, is engraved with names of the organizations that collaborated on this space station technology demonstration: NASA and Made In Space, Inc., the space manufacturing company that worked with NASA to design, build and test the 3-D printer. Made In Space is located on the campus of NASA’s Ames Research Center.

“We chose this part to print first because, after all, if we are going to have 3-D printers make spare and replacement parts for critical items in space, we have to be able to make spare parts for the printers,” Werkheiser said. “If a printer is critical for explorers, it must be capable of replicating its own parts, so that it can keep working during longer journeys to places like Mars or an asteroid and those astronauts won’t have to rely on resupply missions. Ultimately, one day, the printer may even print another printer.”

Made In Space engineers commanded the printer to make the first object while working with controllers at NASA’s [Payload Operations Integration Center](#). As the first objects are printed, NASA and Made In Space engineers are monitoring the manufacturing via downlinked images and videos. The majority of the printing process is controlled from the ground to limit crew time required for operations.

The first objects built in space will be returned to Earth in 2015 for detailed analysis and comparison to identical ground control samples made on the flight printer after final flight testing earlier this year at the Marshall Center prior to launch. The goal of this analysis is to verify that the 3-D printing process works the same in microgravity as it does on Earth.

Click [here](#) to watch a video of Niki Werkheiser, NASA’s 3-D Printing project manager at Marshall, discuss the on-orbit set-up and first test run of the International Space Station’s 3-D Printer.

Hubscher, an ASRC Federal/Analytical Services employee, supports the Office of Strategic Analysis & Communications.

Marshall Center Scientists Launch Worldwide Database of Materials Tested on International Space Station

By Bill Hubscher

American scientists and researchers have a new way to find out how specific materials fared after years of exposure to the space environment. Since the [International Space Station's](#) early days, an experiment called the Materials International Space Station Experiment has exposed almost 4,000 material samples to the harsh space environment. The Informatics Team at NASA's [Marshall Space Flight Center](#) organized, configured and loaded the data received from MISSE into a new online tool for easy access by scientists around the world.

"The Marshall Center's technical capabilities and engineering expertise are vitally important to the nation's goal of sending humans into deep space," said Preston Jones, deputy director of Marshall's Engineering Directorate. "With the development of this database, we are helping to advance space technologies, sparking economic development, and expanding our knowledge so we can share it with the science community -- inspiring the next-generation of explorers to keep the mission alive."

The [online MISSE database](#) contains a large amount of materials test data that may lead to the production of longer-lived spacecraft and satellites. The informatics database falls under the umbrella of the [Materials and Processes Technical Information System](#) -- a ready source for materials properties for NASA and NASA-associated contractors and organizations. The MAPTIS system has information about physical, mechanical and environmental properties for metallic and non-metallic materials.

MISSE ran from 2001 to 2013 as an external fixture outside the space station. The project evaluated the performance, stability and long-term survivability of materials and components planned for use by NASA, commercial companies and the U.S. Department of Defense on future low-Earth orbit, synchronous orbit and interplanetary space missions. MISSE has provided affordable access to space for many materials experiments that could not have flown separately due to cost constraints, potentially saving more than \$150 million by providing environmental and materials data for other spacecraft and missions.



Miria Finckenor, materials engineer at the Marshall Center, prepares to use a spectrophotometer to analyze the reflectivity of coating samples. (NASA)

"We flew several antenna coatings for the Aerospace Corporation and they used that for the Defense Meteorological Satellite Program (DMSP)," said Miria Finckenor, a materials engineer at Marshall. "The results that came from MISSE 7 made enough of a difference that they stripped off the coatings from their last two satellites to replace it with the new coating because it worked that much better."

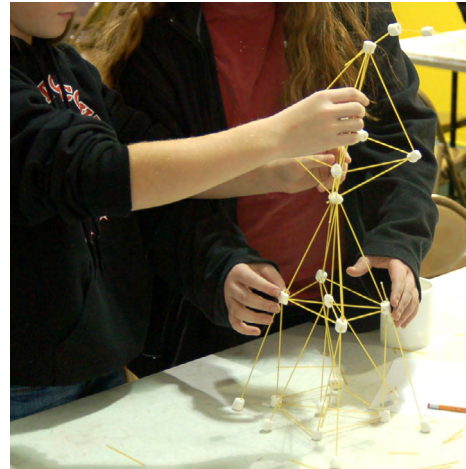
Finckenor did the pre-flight and post-flight measurements of the coating at Marshall. The coating, developed by a team led by Donald J. Boucher, principal engineer and scientist at Environmental Satellite Systems, Aerospace Corp. of El Segundo, California, solved an antenna performance problem.

"We had coated our main reflectors with a material that turned out to be sensitive to water over time. It changes its properties if you have it in a humid environment," said Boucher. "We decided to remove the coating from all our remaining flight units and design a new coating that was very stable with

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Marshall Center Supports American Education Week's 'Expanding Your Horizons' Event

From Nov. 17 to 21, hundreds of girls from middle schools throughout Huntsville learned about NASA's [Space Launch System](#) while completing hands-on engineering activities during "Expanding Your Horizons" week. The event, celebrating American Education Week, was held at the Sci-Quest Science Center. Dozens of accomplished women from local government and industry, including women from the Marshall Space Flight Center's Academic Affairs Office, volunteered to encourage and inspire young females to pursue STEM careers in science, technology, engineering and math. (NASA/MSFC/Christopher Blair)



Katrine Balch, education specialist with the [Marshall Center's Academic Affairs Office](#), talks about the [Space Launch System](#), NASA's next great rocket to ferry astronauts to deep-space locations during "Expanding Your Horizons" week. The week was first initiated at the Marshall Center by then-director Art Stephenson in 2000, who issued an American Education Week proclamation encouraging employees to support the local educational community. (NASA/MSFC/Christopher Blair)

Materials Tested on Station *Continued from page 4*

respect to water."

On April 3, 2014, an Atlas V rocket launched from Vandenberg Air Force Base in California carrying the DMSP-19 satellite into orbit. The DMSP-19 antenna employed the new, MISSE-tested coating.

"We were far less capable of describing vertical distribution of the moisture in the atmosphere with this old antenna coating," said Boucher. "And now we are much, much more capable. We fixed an entire distribution issue with this new antenna coating. All of our satellites have this new reflector coating."

MISSE Database access is available to anyone who acquires a MAPTIS account by applying at the MAPTIS website: <http://maptis.nasa.gov/>.

Hubscher, an ASRC Federal/Analytical Services employee, supports the Office of Strategic Analysis & Communications.



The Polymer Erosion and Contamination Experiment flew outside the International Space Station as part of MISSE. The top image, labeled a., is before flight, and the bottom, b., is the same panel after four years of exposure on the exterior of the station. (NASA)

Marshall Team, NASA Astronaut John Herrington Celebrate Native American Heritage



On Nov. 25, NASA astronaut [John Herrington](#) celebrated Native American Heritage Month at the U.S. Space & Rocket Center, the official visitor center for NASA's [Marshall Space Flight Center](#). Herrington was the first enrolled member of a Native American tribe – the Chickasaw Nation of Oklahoma -- to fly to space and to also conduct a spacewalk. As the featured speaker for the Native American heritage program, Herrington spoke to Marshall team members, hundreds of area elementary students and the public about his [STS-113 space shuttle mission](#) in 2002. (NASA/MSFC/Deaton)

Supernova Shock Waves, Neutron Stars and Lobsters

A supernova that signals the death of a massive star sends titanic shock waves rumbling through interstellar space. An ultra-dense neutron star is usually left behind, which is far from dead, as it spews out a blizzard of high-energy particles. Two new images from NASA's Chandra X-ray Observatory provide fascinating views -- including an enigmatic lobster-like feature -- of the complex aftermath of a supernova.

When a massive star runs out of fuel, the central regions usually collapse to form a neutron star. The energy generated by the formation of the neutron star triggers a supernova. As the outward-moving shock wave sweeps up interstellar gas, a reverse shock wave is driven inward, heating the material ejected by the star.

Meanwhile, the rapid rotation and intense magnetic field of the neutron star -- a pulsar -- combine to generate a powerful wind of high-energy particles. This so-called pulsar wind nebula can glow brightly in X-rays and radio waves.

A long observation with Chandra of the supernova remnant MSH 11-62 reveals an irregular shell of hot gas surrounding an extended nebula of high-energy X-rays. Even though scientists have yet to detect any pulsations from the central object within MSH 11-62, the structure around it has many of the same characteristics as other pulsar wind nebulae. The reverse shock and other, secondary shocks within MSH 11-62 appear to have begun to crush the pulsar wind nebula, possibly contributing to its elongated shape.



Chandra captures a long observation of the supernova remnant MSH 11-62, revealing an irregular shell of hot gas, shown in red, surrounding an extended nebula of high-energy X-rays, shown in blue. Note: The orientation of this image has been rotated by 24 degrees so that north is pointed to the upper left. (NASA/CXC/SAO/P. Slane et al.)

MSH 11-62 is located about 16,000 light years from Earth. The foreground of MSH 11-62 is speckled with hundreds of sources associated with the open stellar cluster Trumpler 18, located at a distance of about 5,000 light years, revealing a vast collection of stars.

NASA's Marshall Space Flight Center manages the Chandra program for NASA's Science Mission Directorate. The Smithsonian Astrophysical Observatory in Cambridge, Massachusetts, controls Chandra's science and flight operations.

A video highlighting 15 years of science from Chandra can be found [here](#).

Marshall Team Puts The 'Fun' In Fundraising With 'No-Shave November'

By Chris Blair

Which would you vote for? The Wolverine, Riddler, Two-Face or Beast?

These classic comic book characters -- turned funny-looking beard designs -- were the poll-voting choices for the 2014 "No-Shave November" fundraiser by the Marshall Space Flight Center's Space Systems Department. Participating team members agreed to shave their beards, matching whichever design received the most monetary donations. The proceeds in turn are donated to local charities through the Combined Federal Campaign -- the annual workplace charity campaign for federal employees that raises millions of dollars each year.

This year's winning design may have been the Wolverine, but the real winners are the New Hope Children's Clinic and the Downtown Rescue Mission, the charities receiving the much-needed donations.

"Supporting these charities is a great way to invest in our community," said Patrick Hull, components and mechanisms team lead of Marshall's Structural and Mechanical Design Branch of the Space Systems Department. "They reach people from hard and hurting places in our area that we don't routinely have contact with," he said. "This was a fun and competitive way to raise support and awareness."

When the final votes were tallied, it was definitely a close shave. The "Beard Alliance" -- the nickname for the participating bearded employees -- donated heavily for the Wolverine design, while others donated for the much more humiliating Two-Face design.

The Two-Face design required shaving either the left or right side of a beard, leaving one side clean-cut, creating two very different profiles. That may have been funny and humiliating, but these bearded good guys are all smiles knowing it's for a good cause.

To learn how you can participate in the CFC, visit [here](#).

Blair, an ASRC Federal/Analytical Services employee, supports the Office of Strategic Analysis & Communications.



These Marshall team members, and others not pictured, agreed to participate in the "No-Shave November" charity fundraising event. (NASA/MSFC/April Dill and Ashley Peeples)



Marshall team members show off their Wolverine beards -- the winning design in the 2014 "No-Shave November" fundraiser. From left are Carl Rudd, Armando Martinez, Robert Champion, Mike Fazah, Mike Selby, Patrick Hull, Jason Waggoner, Jared Dervan, Alex Few, Mohammad Mokhtari, David Parsons, Chris Coppens, Alex Sobey, Ben Craigmyle, Jim Duffy, Daniel Walker, Joao Seixal, Gary Sellers and Mark Davis. Not pictured: Adam Burt and Bob Hawkins. (NASA/MSFC/April Dill and Ashley Peeples)

3-D Printer -- Tested at Marshall Center -- Installed on Space Station

The installation of the first 3-D printer in space was featured in the latest edition of “[This Week @NASA](#),” a weekly video program broadcast nationwide on NASA-TV and posted online.

On Nov. 17, Commander [Butch Wilmore](#) – a Mt. Juliet, Tennessee, native -- installed the printer on the [International Space Station](#). Wilmore placed the printer in the station’s [Microgravity Science Glovebox](#) and began printing calibration samples.

NASA’s Marshall Space Flight Center will monitor 3-D printing from its Payload Operations Integration Center, a facility supporting on-orbit science investigations. The printer is part of the [3-D Printing in Zero-G Technology Demonstration](#), which is investigating the potential for manufacturing hardware during long-duration missions.

3-D printers use computer-generated designs to



create solid objects by melting and extruding spools of plastic. The printer flown to the International Space Station completed its certification testing at the Marshall Center.

This and previous episodes can be viewed at www.youtube.com/user/NASAtlevision.